Chapter 5 NONPOINT SOURCE ASSESSMENT, PRIORITIZATION, AND ACTIVITIES

This section of the Virginia Water Quality Assessment 305(b) Report includes an assessment of nonpoint source (NPS) pollution potential at the 6th order (12 digit) hydrologic unit level of the National Watershed Boundary Dataset (NWBD) (hereafter referred to as either hydrologic units or just units). It also includes indicators for prioritizing NPS corrective actions at the hydrologic unit level and a summary of NPS reduction activities currently underway. It has been prepared by the Virginia Department of Conservation and Recreation (DCR) to provide a comparative evaluation of the state's waters, on a hydrologic unit basis, for assisting in the targeting of limited resources and funds for NPS pollution protection activities to where they are most needed.

The 2014 NPS Assessment and Prioritization study summarizes information from DCR, the Virginia Department of Environmental Quality (DEQ), Virginia Department of Forestry (VDOF), U.S. Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS), local Soil and Water Conservation Districts (SWCDs), the Department of Biological Systems Engineering (BSE) at Virginia Tech (VT), the Virginia Department of Health (VDH), the Virginia Department of Game and Inland Fisheries (VDGIF), the Virginia Department of Mines, Minerals, and Energy (VDMME), the Center for Environmental Studies (CES) at Virginia Commonwealth University (VCU), the US Environmental Protection Agency (EPA), the Chesapeake Bay Program (CBP), the U.S. Geological Survey (USGS), the Conservation Technology Information Center (CTIC), the US Department of Interior – Census Bureau, the American Community Survey, and other existing sources of information useful to the determination of nonpoint source pollution impacts to Virginia waters.

There are three major components to the 2014 NPS Assessment and Prioritization study - potential pollutant loadings, measures of biological health, and NPS reduction activities. An evaluation of NPS impaired waters was not possible for this biennial report due to delays in finalizing the 2012 impaired waters list.

The main focus of this chapter is the determination of potential loadings of nitrogen, phosphorous, and sediment (hereafter referred to as NPS pollutants) by hydrologic unit by general land use classes. The evaluation of hydrologic units by aquatic species health represents water quality measures not necessarily related to the potential NPS pollutant loads. In order to prioritize clean-up and protection activities, hydrologic units of prime importance for the protection of public surface water supplies were also determined. Details on these components follow.

NPS POLLUTION LOADINGS

The NPS Assessment of pollutant loadings is a calculation of the estimated edge of stream (EOS) loadings of nitrogen, phosphorous, and sediment per hydrologic unit using a model whose input data sets had spatial resolutions that were often much smaller than the hydrologic units themselves.

The calculation of loads of NPS pollutants as a basis for assessing water quality by hydrologic unit is consistent with Virginia's participation as a partner with the EPA's CBP in the calculations of NPS pollutant loads using the Chesapeake Bay Watershed Model (CBWM). Although Virginia uses CBWM results (particularly in CBP related activities), they have only been obtainable for that portion of Virginia that is in the Chesapeake Bay Watershed (James, York, Rappahannock, Potomac, and Bay Coastal basins). There are other state program needs that benefit from having measures similar to the CBWM loads but for the non-Bay portion of the state. As has been done since 2002, DCR has produced statewide NPS pollutant load results similar to those of the CBWM by using the Generalized Watershed Loading Functions (GWLF) model[1].

The current GWLF model was calibrated for use in Virginia's NPS Assessment by the VT BSE prior to the 2008 assessment runs. Calibration was done to the observed conditions at 133 monitoring sites across

[1] GWLF was chosen because it was configured for continuous simulation and could produce EOS loads based on land-based loadings, fate, and the transport of pollutants as does the CBWM. Both models also simulate seasonal variations, include both surface and subsurface components, and can represent both dissolved and particulate forms of pollutants. The GWLF model used in the 2014 assessment is an update of the model developed for the 2010 assessment.

Virginia as assembled by the CBP Office primarily from the USGS and the DEQ for the CBWM. Calibration watersheds were created that corresponded to these monitoring station points and were as consistent as possible with existing NWBD unit boundaries. There are portions of Virginia that are downstream of these monitoring sites, however, that could not be calibrated in this manner. To calibrate the model for these portions of the state the BSE defined six physiographic regions covering Virginia. Regions consisted of aggregated 6^{th} order NWBD units and were adjusted to coincide with the aforementioned calibration points. Regionally developed parameter values were then modified during the calibration process of the upstream calibration watersheds until GWLF model output (load results) were sufficiently similar to what has been produced by the CBWM for the Chesapeake Bay drainage area of Virginia for this time period. Final parameter values per region were then assigned to the downstream portion of each region.

Whereas the CBWM uses and produces data in CBWM-specific model segments (36 in Virginia), the assessment runs of GWLF used and produced data at the 6^{th} order hydrologic unit level (1236 in Virginia; 11 other units that are all water were not modeled). Assessment runs of GWLF in 2014 differed from the calibration runs in that they used a land use / land cover data set developed by DCR from a number of sources[2] to represent 2007 conditions. It was necessary to model 2007 conditions because of the source dates of the latest suitable classified land cover data and agricultural census data available when the 2014 NPS Assessment occurred.

NPS pollutant load estimations also took into consideration the model-relevant best management practice (BMP) installations and nutrient management planning occurring in Virginia over the previous five year period (2002-2007) by DCR, VDOF, USDA-NRCS, and private plan writers. Table 5-1 lists the land use classification system used in the assessment runs of the GWLF model and the equivalent generalized model output land use classes. Spatially attributed BMP and nutrient management plan effects are measured as both land use changes[3] to the aforementioned 2007 land use / land cover data set and as fractional reductions to the loadings by modeled land use. Output from the assessment runs of GWLF are in the form of annual loads (L) of each NPS pollutant (p: nitrogen, phosphorous, and sediment) per modeled land use[4] per unit. From this, two forms of unit area loads are calculated – a per hectare (h) of general output land use class (l: agriculture, urban, and forest) per unit (w) load (luUAL) and a per hectare of total modeled land (a) per unit (w) load (UAL).

The luUAL value is preferable to the load values themselves when comparing the loading impacts of the individual output land use classes between units. They are normalized in that the size of the unit does not impact this value. This measure can isolate high loading rates of the general land use classes. It is calculated as:

$$luUAL(plw) = L(plw) / h(lw)$$

While the above calculation is useful it does not necessarily identify those *units* in which NPS reduction activities should be focused[5]. Therefore the UAL was used for ranking hydrologic units in this assessment report but significant luUAL values were used in flagging units in need of attention. The UAL per output land use class per pollutant for each hydrologic unit is calculated as follows:

[2] The base spatial layer for the 2007 land use / land cover data set was the 2006 National Land Cover Dataset (NLCD) . Agricultural uses were modified using the USDA 2007 Census of Agriculture and the 2007 National Crop Residue Management Survey from the CTIC. Barren classes were modified using data from the VDMME. Disturbed forest was determined with the help of VDOF timber harvesting data. Additional classes were based on processes developed for DCR by The Academy of Natural Sciences of Philadelphia (1997) using data from DCR's confined animal databases.

[3] It was not necessary to change the land use to represent land use change NPS BMPs in this assessment because they were already captured in the source data.

[4] Not all land uses were modeled (see Table 5-1). The area of a particular unit as used in these calculations would not include the hectares of non-modeled land uses occurring in that unit.

[5] For instance, units with high loading rates for agricultural land may have only a small amount of this land use and therefore small total loads of pollutants from agricultural uses. Furthermore, any action (if possible) in any year could encompass all reasonable reduction activities, thus making this unit unworthy of further attention.

$$UAL(plw) = L(plw) / h(aw)$$

The output loadings provide a statewide equivalent of the types of results that Virginia has been able to obtain from the CBWM for the Chesapeake Bay drainage area of the Commonwealth over the last twenty seven years. Table 5-2 reports the final statewide loadings by pollutant by general land use class and the amount of land in Virginia by general land use class. Loading values in this table reflect the loads after the reductions are applied from BMP installations over the previous five years.

Table 5-1 Land Use Classification

Original Class	Derived Class	Modeled Class	General Output Class
Pine Forest Hardwood Forest Mixed Forest		Forest	Forest
Forest Harvest		Disturbed Forest	
Crop Bare Soil (portion)	Conventional Tillage Conservation Tillage Hay Unimproved Pasture Pasture Cattle-Grazed Pasture Poultry Litter Manure Acres	Conventional Tillage Conservation Tillage Hay Unimproved Pasture Pasture Cattle-Grazed Pasture Poultry Litter Manure Acres	Agriculture
Pavement Rooftop		Impervious Urban	Urban
Residential/Industrial Grassland Bare Soil (portion)		Pervious Urban	
Natural Barren Extraction		Barren	
Open Water Salt Marsh		not modeled	

There are a number of factors that can account for loading estimation changes between the 2010 and 2014 assessment calculations. Most involve updated and improved data, as the model was not recalibrated and model code remained the same. New and updated data includes more exact soil parameter distribution, a new land use dataset, new non-sewered population figures, updated animal types and counts as well as distribution determinations, revised manure spreading regions, updated determinations of the dominant crop(s) by unit, and new NPS BMP installations and pollutant reduction values.

For consistency with other circulating NPS assessment reports and maps and with the manner in which this data is used, the ranking of hydrologic units for the NPS pollutant UAL components for the 2014 NPS Assessment study has maintained the same division of UALs into categories that has been used before - the highest 20% of the values for each component being classified as high, the next 30% being classified as medium, and the remaining 50% classified as low. This ranking methodology applies to the NPS pollutant loads only. These range definitions are not absolute, since units with equal or very similar loading values would not be divided into different classes.

Information regarding the NPS pollutant loadings by general land use and as summations per pollutant is found within the following sections.

Table 5-2 Statewide NPS Pollutant Loads – Post BMP Reduction

	Agricultural Class	**Urban Class**	**Forestry Class**
Total VA Land Area *#	5,616,464	2,411,465	16,889,216
%of VA Land *	22.2	9.5	66.7
Total Nitrogen **	31.3	10.3	3.6
%of all NPS N ^	68.6	22.5	7.9
Total Phosphorous **	4.8	0.7	0.6
% of all NPS P ^	75.5	10.9	9.4
Total Sediment **	2,089.2	.13	1,357
% of all NPS S ^	50.3	3.1	32.8

* Units are acres.
\# Does not include 388,964 acres of nonforested wetlands and barren land (see Table 5-1).
^ Includes loads from barren and extraction.
** Units are millions of Kg/year.

Agricultural NPS Pollution Loads

Agriculture is a large and diverse industry in Virginia and accounted for a little more than 22% of Virginia's land use in the year being assessed. While this percentage is significantly lower than the national average and continues to decline in Virginia, agricultural activities remain the most significant source of nonpoint source pollution in the state. As shown in Table 5-2 and as the current and all past assessment model results suggest, agricultural land in Virginia contributes NPS pollutant loads in greater proportion to the area they comprise than do the other land use classes. Estimated loadings from agriculture in this assessment for Virginia have declined from the past for sediment but have increased slightly for nitrogen and phosphorous despite a reduction in agricultural lands. Animal concentrations and predominant crop changes are likely causes for these increased NPS pollutant loads.

Nonpoint source pollutants from agriculture originate from several different sources with different associated impacts. Deposition to agricultural lands in the form of fertilizers and animal manures affect water quality when they reach groundwater reserves, are directly deposited to streams, or are washed into streams, lakes, etc during rain events in either a dissolved state or with eroding soils. These pollutants include pathogens as well as nutrients.   Farming practices can contribute to or retard runoff and can certainly affect the amount of soil lost from fields which can potentially end up in water features.

This assessment measured the nutrient and sediment loads from agricultural areas but not the loading of pathogens. Factors in this assessment which affect the amount of nutrient loads reaching water from agricultural lands include the erodability of the soils, types of agricultural practices, types and numbers of farm animals, land cover, stream density, rainfall, seasonal variations in plant growth and nutrient applications, existence and type of agricultural BMPs, soil saturation, and slope.

The ranked UALs by hydrologic unit of nitrogen, phosphorus, and sediment from agricultural land uses are displayed in Figures 5-1, 5-2, and 5-3 respectively. The rankings are also listed in Table 5-3

There are a few factors that are specific to changes in loadings, and thus ranks, of the agricultural NPS pollutants between the current and past assessment products. An updated land use image is a primary new source. Continued improvements in the calculation of pasture yield for the distribution of non-confined animals (usually beef) occurred, which were assisted by final updates of county soil surveys. The dominant crops data by hydrologic unit was updated with significant changes. Minor updates were made to the farm animal database. There is also a different set of agricultural NPS BMPs installed and operating. As a result there was a shift of many high loading units from agricultural practices to the southeastern portion of the Commonwealth since prior NPS Assessments.

Urban NPS Pollution Loads

Around 9.5% of the land in Virginia was considered urban for the year being assessed. Urbanized land produces NPS pollutants as the result of precipitation washing nutrients, sediment, and other toxic substances from the impervious surfaces that are found in these areas. The sources of these surface contaminants include: air and rain deposition of atmospheric pollution; littered and dirty streets; traffic by-products such as petroleum residues, exhaust products, heavy metals and tar residuals from the roads; chemicals applied for fertilization, control of ice, rodents and other pests; and sediment from construction sites. Improper industrial, commercial and domestic hook-ups to storm sewers also contribute a number of specific pollutants to waterways, as do inadequate and/or improperly maintained sewage disposal systems both for municipalities and individual homes.

This assessment measured only the nutrient and sediment loads from urban areas as opposed to all urban NPS pollutants as described. Factors that are specific to changes in loadings, and thus ranks, of the urban NPS pollutants between the current and past assessment products include an update to the non-sewered population and the updated land cover. Factors that affect the amount of loads reaching water from urban lands include the degree of imperviousness of the urban land use, impervious area NPS pollutant build-up rates, stream density, rainfall, septic system use, direct discharges, soil saturation, and slope.

The ranked UALs by hydrologic unit of nitrogen, phosphorus, and sediment from urban land uses (as described in Table 5-1) are displayed in Figures 5-4, 5-5, and 5-6 respectively. The rankings are also listed in Table 5-3. The highlighted units are reflective of the areas of Virginia that are undergoing significant urban development and redevelopment activity as well as those with significant amounts of marginal septic system use. Urban load measures are based on pollution potential and do not compensate for urban runoff control measures that may be in place in some areas. Such reduction measures are primarily installed by the private sector.

Forestry NPS Pollution Loads

Almost 67% of the land area of Virginia was forested in the year being assessed. Forestland in general produces lower NPS pollutant loads[6] than other land uses. Certain forest disturbing activities such as tree harvesting, site preparation, and reforesting however do make a load contribution. As Table 5-2 shows, these activities contribute more to the sediment load than they do to other NPS pollutants.

Forest land can be harvested as part of a land use change such as residential development, clearing for agricultural fields, or surface mining. Due to the similar spectral signatures in classified land cover imagery of these land activities, as well as those of non-temporary land covers such as bare rock and beaches, it can be difficult to discern them from one another without other associated data. Fortunately

[6] Airborne nutrient pollution is accounted for as part of the load of the land use it falls upon. The majority of the airborne nutrient load falls on forestland in Virginia and is therefore associated more with forestland than with other uses.

the VDOF tracks forest harvesting activities so as to facilitate the proper management of Virginia's forest resources relative to water quality.

Whereas agricultural activities operate on a yearly or seasonal cycle on agricultural lands, a single cycle of forest harvesting, site preparation and reforestation occurs over many years. Where the next cycle begins amongst existing forested lands is undetectable from previous land cover images, making the measure of forest disturbance for these activities more of a snapshot than a trend. As such, the ranking of hydrologic units for forest based loads varies more between NPS Assessments for forest harvesting units than does the loads of other land use classes.

Factors in this assessment that affect the amount of loads reaching water from forestlands include the erodability of the soils, existence of disturbed forestlands, stream density, rainfall, existence and effectiveness of forest (silviculture) BMPs, soil saturation, and slope.

The ranked UALs by hydrologic unit of nitrogen, phosphorus, and sediment from forestland uses are displayed in Figures 5-7, 5-8, and 5-9 respectively. The rankings are also listed in Table 5-3.

The factors most responsible for the changes in loadings, and thus ranks, of the forest NPS pollutant loads in this assessment include the new land use dataset, updated forest harvesting information from VDOF, and improved accounting of silviculture BMPs and their effectiveness.

NPS Pollution Loads of Other Land Uses

Extraction and non-urban barren lands have not been lumped into any of the output land use classes with regards to reporting loads or unit area loads (see Table 5-2). They also therefore do not influence the ranking of units for any of the load classes.

Using spatial data of resource extraction from the VDMME helped isolate true extraction activities from reforesting sites, urbanization, or other land clearing activities. The spatial distribution of extraction land use was used in conjunction with county level recordings of extraction activity.

Approximately 4% of the phosphorous, 1% of the nitrogen, and 14% of the sediment load in the 2014 NPS Assessment was associated with these barren and extractive land uses. These loadings were very localized however, having significant potential impacts to water quality in a small percentage of units. The area where these loads were highest was in the Clinch and Powell River basins. Slightly lower barren land loads occurred in the Big Sandy basin with less but noticeable loads coming from barren lands associated with fringe urban development.

Total Loads Per NPS Pollutant

Calculated total nitrogen, total phosphorous, and total sediment unit area loads from all land uses combined, including the other uses noted above, are displayed in Figures 5-10, 5-11, and 5-12 respectively, and listed in Table 5-3. Total nitrogen is composed of septic nitrogen, groundwater nitrogen, dissolved nitrogen from various land uses, wash off of nitrogen from impervious surfaces, and sediment-attached nitrogen. Total phosphorous is composed of septic phosphorous, groundwater phosphorous, dissolved phosphorous from various land uses, wash off of phosphorous from impervious surfaces, and sediment attached phosphorous. Total sediment is the sediment yield from all land uses.

The summing of NPS pollutant loads by land use into total NPS pollutant loads in this NPS assessment is simply the addition of values with equivalent units (kg/ha/yr of nitrogen or phosphorous, Mg/ha/yr of sediment). Accordingly, the relative weight of the estimated NPS pollutants coming from one land use versus another is directly comparable. This comparison shows that NPS pollutants from agricultural lands dominate the total NPS pollutant loads although barren lands can be heavy contributors where they occur in some concentration.

BIOLOGICAL HEALTH

Additional components for evaluating the affects of nonpoint source pollution include the VDH public surface water sources and their protection zones, and an evaluation of the health of aquatic species in the state's waters by the CES at VCU. These components provide an additional means to prioritize water quality protection - the protection of the sources of public drinking water and of natural aquatic communities respectively.

Public Source Water Protection

As part of their Source Water Area Protection (SWAP) Program, the VDH determined the area upstream of public surface water intakes that must be investigated for threats to water quality. The most immediate area of their concern is referred to as the Zone 1 for each intake. Zone 1 areas extend out to a 5 mile radius upstream from a water supply intake or 5 miles around a lake containing an intake, without crossing watershed boundaries except those upstream. The population served by an intake, provided by VDH, and the portion of a hydrologic unit that is within a Zone 1 area has been used by DCR to calculate the concentration of persons served per unit by these public surface water supplies. The concentration values serve as a measure of the importance of high water quality by hydrologic unit for public drinking water supply protection.

Concentration values are the summation by hydrologic unit of all Zone 1 areas or combinations of Zone 1 areas in that unit times one one-thousandth of the effective population each serves. In cases where a municipality owned several intakes, the single recording of population served was divided amongst each intake to create an effective population served. In cases of overlapping intake reaches the effective population of each reach was summed for the portion of overlap.

The categorized values and rankings for indicating concentration by unit are displayed in Figure 5-13 and listed in Table 5-3. Unlike the NPS loading variables in this assessment, where units that are ranked high represent units of concern, the high ranking public source water units are just units with a high need for water quality protection. A significant amount of their area lies immediately upstream from surface water intakes that are used extensively for public drinking use by many people.

The vast majority of hydrologic units contained no Zone 1 protection zones or portions of Zone 1 protection zones. Of those with some Zone 1 content, the majority had low levels (< 10) of the calculated measure for concentrations of people served within a watershed. Of the remaining units, a few had significantly higher value measures (> 100) and were therefore classified as having a "Very High" need for source water protection. The rest were divided amongst a moderate category (10-30) and a high category (30-100).

Only modifications done to improve the accuracy of this product have occurred in recent years. However the VDH has recently contracted for an update to their SWAP layer.

Aquatic Species Measures

The presence or absence of certain aquatic species can serve as an indication of the overall quality of a particular waterway. They can also indicate where the most biological damage can occur from water quality degradation. Accordingly, the NPS Assessment and Prioritization study provides a ranking of hydrologic units for stream-dependent living resources (including fish, mollusks, and crayfish) using a multi-metric index calculated by the CES at VCU as part of their Interactive Stream Assessment Resource (INSTAR).

These indexes (referred to as the mIBI - a modified version of the Index of Biological Integrity) are calculated by the CES using databases originally developed by DCR, the VDGIF, and VCU[7]. More than 162,000 database records from over 2000 aquatic collections have been gathered since INSTAR's conception. As a result it is possible to calculate a mIBI value for more than 93% of the 6^{th} order units of the NWBD. An equally beneficial result from having more records available for any unit is the decreased likelihood of a false prioritization indication based on minimal information.

[7] More information about the mIBI and the other components of INSTAR can be found at http://instar.vcu.edu.

By associating a hydrologic unit code to each of the stream segments for which aquatic species information was available in the various databases, metric scores by unit were developed for each of 6 metrics. These metrics are as follows:

- Metric 1 – Number of Intolerant Species: refers to the total number of unique water quality intolerant species found in a unit.
- Metric 2 - Native Species Richness: refers to the number of indigenous (local) species present in a unit.
- Metric 3 - Number of Rare, Threatened and Endangered Species: refers to the number of species that are considered rare, threatened or endangered due to their low population levels that are present in a unit.
- Metric 4 - Number of Non-indigenous Species: refers to the number of non-native species present in a unit. These are introduced species that would not normally be found in this particular location.
- Metric 5 - Number of Critical Species: refers to the number of species found in a unit that are considered critical because of some important role that they play, such as being a food source or major recreational fishery.
- Metric 6 - Number of Tolerant Species: refers to the number of species found in a unit that are tolerant to degraded stream conditions and can survive even in these sub-optimal conditions.

A score of 0 – 5 was assigned by the CES for each metric based on the metric's values. In general high metric values were assigned high metric scores - indicative of high stream health. A score of zero was given if insufficient data was available. Of the 1247 hydrologic units, 97 (8%) were assigned a zero for this reason. Metrics 4 and 6 were reversed in the scoring, since a low value for either of these metrics would indicate high stream health. Therefore a high metric score was given for low metric values for these two metrics. Lower values are more desirable in metrics 4 and 6 because a high number of non-native species and/or a high number of species that are tolerant to stream degradation are less desirable characteristics for a stream.

Scores for each metric for each unit were totaled to give an overall total mIBI score per hydrologic unit. These summed scores per hydrologic unit were then tiered relative to the summed scores of the other units in the same basin by assigning a category value of High (score of 5), Medium (score of 3), or Low (score of 1) on a per metric per basin basis. The resulting total mIBI scores are used to place each hydrologic unit into ranked categories reflecting biotic integrity and resource importance.

Since there were 6 metrics and a maximum score of 5 could be obtained for each metric, the overall maximum score a unit could receive was 30 (6 x 5). Just under 8% of the units (97) are considered to have very high biodiversity, with total mIBI scores of 20 or more. Another 193 units have total mIBI scores of at least 18. At the other end of the spectrum, 6.3% of the units (78) with sufficient data have total metric scores of 10 or less – indicative of low biodiversity. These units most probably contain waters with some degree of degradation.

Figure 5-14 displays, and Table 5-3 lists, the categorization of the mIBI scores by hydrologic unit. In this figure and table, high mIBI scores equate to areas of high biotic integrity. Whereas low mIBI ranked units represent units of concern in regards to low water quality based on aquatic species measures, high ranked units represent areas of importance for the protection of the state's streams of exceptional biodiversity. The majority of the changes in total mIBI scores occurred in the southwest portion of the state and may be due to increased data collection in that area rather than an increase in water quality degradation.

While the maintenance or enhancement of water quality for the protection of all native aquatic life is the preferred goal, these aquatic species priorities should help direct NPS pollution mitigation efforts and other water quality improvement projects toward hydrologic units with the most important aquatic resources.

COLLECTIVE USE OF RANKINGS

The 12 rankings assigned to hydrologic units for NPS pollutants by land use class and the 2 rankings of units for biological health can be used in various combinations to evaluate statewide conditions and prioritize NPS reduction activities. Which measures are included in each prioritization process, and how one weighs in comparison to another, depends on the activity to be prioritized. For instance, DCR uses the agricultural NPS pollution rankings as variables in the targeting of agricultural best management practices (see Agricultural Cost Share Program below) and rankings of NPS pollutant loads and biological health were part of the TMDL implementation prioritization (see Total Maximum Daily Loads below).

There are a number of considerations to keep in mind when constructing prioritization processes using these rankings. Perhaps the most important is that some factors are measures potentially being produced at the hydrologic unit of interest, such as the NPS pollutant loadings. Other measures reflect existing conditions at the unit of interest, such as aquatic species health, and may in part be due to activities occurring in upstream units. The source water concentration values directly account for the upstream affect by virtue of their being based on a designated upstream zone.

Another consideration is the possible incorrect inference of cause and effect. Waters in a hydrologic unit may be impaired due to nonpoint sources but the cause of these waters being listed as impaired is often not related to the nitrogen, phosphorous, and sediment that is potentially being loaded to these waters in either the unit of concern or upstream of it. Likewise point source loadings can be the reason for the streams in a unit to collectively produce a low mIBI score and aquatic species rank.

In the 2014 NPS Assessment and Prioritization some units have been flagged for a number of conditions that can be determined by comparing the rankings of measures in this report. The flags have been entered into Table 5-3. The conditions are:

Exceptional aquatic biodiversity.
1> Units (10) with mIBI scores of 24 or greater.

High aquatic biodiversity with potentially high NPS pollutant loads.
2> Units (7) with mIBI scores of 18 or greater and all high ranked total NPS pollutant loads.

High public water supply protection need with potentially high NPS pollutant loads.
3> Units (8) with source water concentration values greater than 30 and any high ranked total NPS pollutant load.

Excessive agricultural loadings.
5> Units (21) with agricultural nutrient loads greater than 4 times the standard deviation from the mean agricultural nutrient load.
6> Units (11) with agricultural sediment loads greater than 4 times the standard deviation from the mean agricultural sediment load.

NPS REDUCTION ACTIVITIES

Efforts to reduce NPS pollution in Virginia have been undertaken by a full range of government agencies - federal, state, regional, and local, as well as by citizen action. In many cases the activities are cooperatively performed and funded. Descriptions of the cooperative NPS reduction activities can be found at the NPS Management Plan website and document. Most of these efforts target particular watersheds. Among them, and elaborated on here, are the TMDL studies and implementation, Nutrient Management, Agricultural Cost Share incentive programs for BMP installations, and incentives for the set aside of agricultural land.

Total Maximum Daily Loads

TMDLs, described elsewhere in this 305(b) report, are performed for waters that have been determined to be impaired and are so listed in the State's 303(d) report. Streams are not listed as impaired however due to high concentrations of nitrogen, phosphorous, or sediment, but rather because they cannot support, or can only partially support, one or more of the five designated uses. This is because water quality standards do not exist for concentrations of these NPS pollutants for free-flowing waters. Nevertheless, certain impairment causes are primarily due to nonpoint source pollutants (see Impaired Waters in this chapter) and DEQ staff has often determined that there are nonpoint sources for these impairments.

Using the logic of the impaired waters rankings of the NPS Assessment study, all impairments for which one or more of the stages of a TMDL have begun were divided between those with and those without a nonpoint source. Most of the waters declared impaired in Virginia are, or are believed to be, impaired due to, or partially due to, nonpoint source pollution. Consequently, most of the TMDLs that are being undertaken have a nonpoint source component. These studies are focusing on identifying the sources of the impairment causes, quantifying the loadings of these sources to the water, and determining the reduction in loads needed in order to meet the use criteria. The development of an implementation plan is expected following the completion of a TMDL study for a particular watershed. Implementation of the plan's course of action then follows.

The number of TMDLs underway or completed is continually increasing. Table 5-4a lists the NPS TMDL Study Reports (excluding shellfish) and Table 5-4b lists the NPS TMDL Implementations Plans as of April 2013 by their status, which is a temporal condition. At that time there were 74 completed NPS dominated TMDL Implementation Plans covering 495 impaired waters with another 11 underway covering 109 impaired waters. In addition there were 206 NPS dominated TMDL Studies covering 922 impaired waters that have been approved by the EPA, with another 48 studies under development covering 187 impaired waters. The number of TMDL Study Reports completed cannot be directly compared to Implementation Plans completed as the geographic area and impaired waters included may vary; that is, an Implementation Plan may be developed for only a portion of a TMDL Study.

Whereas it is streams or water bodies that are listed as impaired, it is the watershed of those impaired stream segments and water bodies that are the focus of nonpoint source pollutant reduction activities. The hydrologic units listed in Tables 5-4a and 5-4b are those in which some portion of the unit contains the listed impaired stream segment. Sometimes the entire area of the listed hydrologic unit is the watershed of the impaired stream segment, but often only a portion of that unit must be studied for a TMDL. Figure 5-15a shows the true TMDL study areas and thus gives a better indication of the geographic extent of where the work is being performed. One difficulty in geographically representing the extent of multiple TMDL areas is that they often overlap – the watershed of a TMDL for a headwaters stream becomes part of the watershed of a TMDL for a larger water feature downstream. In Figure 5-15a the EPA approval status of the latest TMDL work is assigned visual priority. Figure 5-15b likewise shows the true TMDL Implementation Plan areas which also include geographic overlap.

Agricultural Cost Share Program

The Virginia Agricultural Cost Share Program (VACS) offers incentives to farmers and agricultural land- owners to encourage the installation and use of a number of approved techniques (BMPs) for reducing agricultural related nonpoint source runoff. While the program aims to address nonpoint source pollutants statewide, specific hydrologic units are targeted based on the agricultural loads estimated from the NPS Assessment study (see Agricultural NPS Pollution Loads) and other factors. Soil and Water Conservation Districts further target the practices to individual needs within their district within these load priority areas.

Funding for the implementation of these practices has been borne by the state and the federal government since the program's inception in 1985. The number of installations per year has varied widely over the years, correlating with the variation of funds available to the program. At this time the primary funding source is the Virginia Natural Resources Commitment Fund, a subfund of the Water Quality Improvement Fund (WQIF)established by the Commonwealth's Water Quality Improvement Act (WQIA). Other state and federal funds may be used however, such as Chesapeake Bay Implementation Grants.

Table 5-5 contains the estimated NPS reductions by basin from the VACS Program for program years 2012 and 2013, as well as the state's costs to attain these reductions. The $34,630,050 of total VACS costs for this program in this table is a 27.4% increase over the amount of expenditures from the 24-

month period of Program Years 2008 and 2009 as reported in the 2012 305(b) Report. As might be expected therefore, there is an increase in the reported estimated loads of NPS pollutants that are being reduced.

Additional information on agricultural best management practices and the cost-share program can be found at http://www.dcr.virginia.gov/soil_and_water/costshar.shtml. Other efforts to reduce NPS pollutants include local and state stormwater controls, BMP installations by the USDA, and silviculture BMP installations by the VDOF. These and other pro-active efforts increase the reductions reported and negate estimated loads as calculated in the NPS pollution loadings of this assessment.

Table 5-5 NPS BMP Pollutant Reductions and Costs, Program Years 2012 & 2013
1 July 2011 through 30 June 2013

	Ag Cost Share Totals				CREP Totals			
BASIN	Tons SL Reduced	Lbs N Reduced	Lbs P Reduced	State Cost ($)	Tons SL Reduced	Lbs N Reduced	Lbs P Reduced	State Cost ($)
POTOMAC *	70629	384225	60029	2,276,302	2	11	1	19,262
SHENANDOAH	90505	492348	112213	3,313,299	9017	49051	11214	259,633
RAPPAHANNOCK	57905	315003	55863	3,671,440	1383	7526	1090	46,989
YORK	95127	517488	92701	3,267,511	1061	5770	810	68,400
JAMES	1071201	5827333	1551643	6,636,272	5215	28369	5133	436,046
BAY COASTAL	33415	181779	43895	1,506,724	0	0	0	0
OCEAN COASTAL	24684	134278	33592	751,807	19	101	24	1,999
ALBEMARLE SOUND	31108	169225	42796	713,152	0	0	0	0
CHOWAN	608281	3304945	904806	2,908,988	675	3669	1191	37,543
ROANOKE	212188	1154301	236007	3,905,865	3696	20189	4149	229,121
YADKIN	4344	23630	4344	79,152	123	666	123	8,411
NEW	105412	573444	102490	1,923,991	5104	27767	4964	260,622
CLINCH/POWELL	34976	190272	37429	2,050,737	1344	7309	1332	60,330
HOLSTON	57454	312549	63018	1,227,989	12250	66640	13129	128,011
BIG SANDY	519	2822	519	396,822	0	0	0	0

*excludes the Shenandoah

Conservation Reserve Enhancement Program

The USDA's Conservation Reserve Program (CRP) provides incentives for the removal of agricultural land from production to protect environmentally sensitive land alongside rivers and streams. The Virginia Conservation Reserve Enhancement Program (CREP) augments CRP by providing for state enhanced cost-share and rental payments for conservation practices focused on the restoration of riparian buffers and wetlands. The Virginia CREP also funds the purchase of conservation easements on the restored riparian buffers.

Most but not all areas of the state qualify for CREP assistance. Table 5-5 contains the estimated reduction of nonpoint source pollutants by basin for program years 2012 and 2013 from the Virginia CREP, as well as the state's costs to attain these reductions. The $1,556,365 of total state costs for this program in this table is only about one fifth of the amount of expenditures from the 24-month period in Program Years 2008 and 2009 as reported in the 2012 305(b) Report. As a result there is a significant decrease in the reported estimated loads of NPS pollutants that are being reduced from CREP installations The USDA's CRP increases the reported reductions. Information about CRP can be found at http://www.nrcs.usda.gov/programs/crp/. Additional information on the Conservation Reserve

Enhancement Program can be found at http://www.dcr.virginia.gov/soil_and_water/crep.shtml.

Nutrient Management

The Virginia Nutrient Management Program which is administered by Code 10.1-104.2 is designed to detail the most efficient use of fertilizers and manures on farms and urban lands in the Commonwealth. Plans are customized to fit a particular operation. The potential productivity of each field is considered along with an inventory of available nutrients from the soil, crop residues, manures and commercial fertilizers. Nutrient Management Plans are flexible, based upon crop responses to nutrients, and focus on efficiently using those nutrients.

In Virginia, nutrient management plans are created by nutrient management specialists employed by DCR. These specialists offer hands-on assistance with soil and tissue sampling, using soil surveys, equipment calibrations, and interpreting results to improve farmer efficiency. DCR has a staff of 18 specialists who assists farmers, mostly of animal operations, in developing and implementing nutrient management plans.

There is also a private sector involvement in nutrient management activities. State-wide there are currently 453 certified nutrient management plan writers, who record the majority of the acreage being managed each year. In addition, Virginia has an Urban Certification program with 124 certified plan writers. These plans are written for urban lands consisting of state owned lands, golf courses, businesses, and other urban areas.

State-wide there are now almost 1,000,000 acres with a current nutrient management plan. Table 5-6 contains an accounting of the plans written in both 2012 and 2013.

Table 5-6 Acres Placed Under a Nutrient Management Plan and Estimated Nutrient Reductions, Calendar Years 2012 & 2013

Basin	*Crop Acres*	*Hay Acres*	*Pasture Acres*	*Specialty Crop Acres*	*Nitrogen Reduced**	*Phosphorous Reduced**
Albemarle Sound		7			56.3	5.6
Big Sandy		31	200		1708.8	174.1
Chowan	10190	1061	540	47	38321.2	3901.6
New	3815	2395	4491	82	79775.2	8122.2
Roanoke	10498	3468	3565	26	129883.9	13223.8
Clinch/Powell	842	2052	4079		51587.6	5252.2
Holston	2850	3961	5577		91659.6	9332.3
Yadkin		24	7	243	2021.4	205.8
Non-Bay Total	28195	12999	18644	398	444967.1	45303.5
Bay Coastal	972	53	47	66	173780.3	78621.5
James	11916	9825	6446	1177	550651.0	249125.0
Potomac **	6965	2118	1525		288680.7	130604.6
Shenandoah	11471	11107	10655	7	1303799.1	589863.5
Rappahannock	17961	567	298	116	644264.5	291477.4
York	377	40	83		31810.4	14391.5
Bay Total	49662	23710	19054	1366	2992986.0	1354063.5

* reductions in lbs/year

** excludes the Shenandoah

Additional information on the Commonwealth's nutrient management program can be found at http://www.dcr.virginia.gov/soil_and_water/nutmgt.shtml.